

## SECTION 02731 - GRAVITY SANITARY SEWERS

### PART 1 - GENERAL

#### 1.1 GENERAL

- A. This section covers all work necessary for the installation of gravity sanitary sewers and related items complete, including manholes, junction chambers, diversion chambers, house/building services, grease traps, and miscellaneous concrete structures.
- B. Sewer pipe shall be the size shown on the drawings prepared and certified by a registered professional Engineer and shall meet all requirements of these specifications. Drawings and specifications shall be submitted to and be approved by the Zionsville Town Council prior to any construction.
- C. All food establishments shall install grease traps.

#### 1.2 PIPE MARKING

Each length of pipe shall bear the name or trademark of the manufacturer, the location of the plant, and the date of manufacture. Each length shall likewise be marked to designate the class or strength of the pipe. The marking shall be made on the exterior or interior of the pipe barrel near the bell or groove end and shall be plainly visible.

#### 1.3 SUBMITTALS

Before construction and preferably before fabrication, the Contractor shall submit to the Engineer for approval calculations on the thickness or strength class and drawings showing pipe lengths, joints, and other construction and installation details. All pipe furnished under this Contract shall be fabricated only in accordance with the drawings and these specifications. Contractor shall submit shop drawings for all material to be used for approval by the Town Engineer before commencing with construction.

#### 1.4 QUALITY ASSURANCE

- A. Performance Tests: The Contractor shall test all gravity sewers constructed under the Contract. The Contractor shall constantly check horizontal and vertical alignment. Testing for vertical deflection in the case of non-rigid pipe and sewer watertightness testing in the case of all gravity sewers and hydrostatic testing of ductile iron pipe shall be as specified in this Section.

- B. Line and Grade Requirements: The Contractor shall provide assurance to the Engineer or the Engineer's representative that the sewer is laid accurately to the required line and grade as shown on the drawings. The Contractor shall utilize a laser beam instrument to lay and check the alignment and grade between manholes. Before proceeding with the next section of sewer, the last section shall be checked for proper line and grade. Variations from a uniform line and grade as shown on the drawings and described below shall be cause for the line to be rejected.
1. Variance from established line and grade shall not be greater than  $\frac{1}{32}$  of an inch per inch of pipe diameter and not to exceed  $\frac{1}{2}$  inch, provided that such variation does not result in a level or reverse sloping invert; provided also that the variation in the invert elevation between adjoining ends of pipe, due to non-concentricity of joining surface and pipe interior surfaces, does not exceed  $\frac{1}{64}$  inch per inch of pipe diameter or  $\frac{1}{2}$  inch maximum.
- C. Test Sections
1. Initial Performance Test: An initial performance and leakage test will be performed on the first sections of sanitary sewer constructed of approximately 600 feet in length of each size and type sewer material installed. No additional sewer pipe shall be installed until the first section of sewer of each size and type of sewer material has satisfactorily passed the test for line and grade and the leakage test.
  2. Subsequent Performance Testing: After the initial performance test and leakage test and as work progresses, the Engineer may designate additional sections for testing as conditions in his opinion warrant. If a review of the Contractor's workmanship leads the Engineer to question whether or not the tolerances and standards specified are being met, the Engineer reserves the right to select other locations and lengths to be tested. The Engineer shall notify the Contractor of the location where a test is to be required not later than 15 days after the sewer installation has been completed. Unless otherwise authorized, the Contractor shall arrange to commence the test within 15 days after the sewer has been installed or 15 days after receiving notification by the Engineer, whichever date is later.
  3. Final Performance Testing for Acceptance: Before acceptance of all new sanitary sewers, the Contractor and the Engineer or the Engineer's representative shall check all sewers, even if previously checked, for accurate alignment and grade. Also, all sanitary sewers shall be tested as specified in Articles 3.9 through 3.13 of this Section for watertightness. The program of testing whether by

infiltration, exfiltration, air testing, or vacuum testing shall be determined by the Engineer.

## 1.5 LENGTH OF OPEN TRENCH

Except by permission of the Engineer, not more than 450 feet of trench shall be opened at any one time. Not more than 30 feet of trench may be opened in advance of the completed pipe laying operation, and not more than one street crossing may be obstructed by the same trench at any one time.

## 1.6 RELATION TO WATER MAINS

- A. Sewers must be laid at least 10 feet horizontally from any existing or proposed water main. The distance is to be measured edge to edge. Should specific conditions prevent this separation, the Contractor shall notify the Engineer for specific instructions regarding the treatment of the separation. Special conditions may allow installation of the sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer and at an elevation so the bottom of the water main is at least 18 inches above the top of the sewer. It may be necessary to install 150 psi water main pipe and joints as sewer pipe for the congested areas.
- B. Whenever the sewer crosses a water main, it should be laid at least 18 inches below the main, or the water main should be relaid with fittings to cross over the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints.
- C. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be designed and constructed equal to water pipe, and shall be pressure tested to assure watertightness prior to backfilling. Maximum distance between sewer pipe joints and water pipe shall be provided where vertical separation is a problem.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Sewers 15 Inches or Smaller
  - 1. Sewers 15 inches in diameter or smaller shall be polyvinyl chloride pipe or ductile iron pipe.

2. Polyvinyl Chloride Pipe and Fittings
  - a. Polyvinyl chloride pipe and fittings shall conform to ASTM D3034 SDR 26, Type PSM, latest revision.
  - b. Maximum diameter of PVC sewer pipe to be used is 15 inches.
3. Ductile Iron Pipe and Fittings: Ductile iron pipe and fittings shall conform to the requirements of ANSI/ASTM A746, Ductile Iron Gravity Sewer Pipe.
  - a. Thickness class requirements of ductile iron pipe to be used in conveyance of sanitary sewage by gravity shall be minimum thickness of Class 350 unless otherwise noted for standard length pipe.
  - b. Outside surfaces of the pipe and fittings shall be bituminous coated complying with ANSI/AWWA A21.51/C151 and ANSI/AWWA A2110/C110.
  - c. Inside surfaces of all pipe, fittings and adapters shall be lined with cement mortar and a bituminous seal coat. Cement mortar lining and bituminous seal coat shall meet the requirements of ANSI/AWWA A21.4/C104.
  - d. Ductile iron pipe and fittings shall be push-on type conforming to ANSI A21.11 (AWWA C111), latest revision. Fittings shall be ductile iron and shall comply with ANSI Specification A21.10, latest revision, with mechanical joints for 150 psi working pressure.
4. Joints for PVC Sewer Pipe
  - a. Joints on PVC sewer pipe shall be the integral bell type gasketed joint designed so that when assembled the elastomeric gasket inside the bell is compressed radially on the pipe spigot to form a positive seal. The joint shall be so designed to avoid displacement of the gasket when installed in accordance with manufacturer's recommendations. The joint shall comply with the physical requirements of ASTM D3212, and the gasket shall be the only element depended upon to make the joint flexible and watertight.
  - b. All PVC Pipe entering a manhole shall have a manhole waterstop gasket as supplied by the manufacturer firmly clamped around the pipe at the manhole. If flexible entry type manhole system is used, the waterstop gasket is not required.

B. Fittings

1. Fittings such as wyes, tees, and bends shall be made in such a manner as will provide strength and watertightness at least equal to the class of the adjacent main line pipe to which they are jointed and shall conform to all other requirements specified for pipe of corresponding class and internal diameter. Joints shall be of the same type as used on the adjoining pipe.
2. Fabricated branches for wyes and tees shall be securely attached to the wall of the pipe in a watertight manner and shall be flush with the inside surface of the pipe. The branches shall have their axes perpendicular to the longitudinal axis of the pipe. Wye branches shall have their axes approximately 60 degrees for clay pipe and 45 degrees for concrete pipe from the longitudinal axis of the pipe, measured from the bell end. Pipe reinforcement shall not be interrupted beyond a radial distance of 3 inches outside of the fitting.

C. Manholes and Other Structures: Manholes shall be constructed of monolithic concrete or precast manhole sections. Precast manhole sections shall conform to requirements of ASTM Specification C478, latest revision.

1. Materials for manholes, junction chambers, diversion chambers, and miscellaneous concrete structures shall comply with the following:
  - a. Concrete for precast manhole sections shall be 3000 psi concrete. Monolithic manholes shall use 4000 psi concrete. Ready-mix concrete shall conform to ASTM C94 Alternate 2. Maximum size of aggregate shall be 1-1/2 inches. Slump shall be between 2 and 4 inches.
  - b. Forms for chamber and structures shall be plywood or other approved material. Steel forms shall be used for the inside face of monolithic concrete manholes.
  - c. Reinforcing steel shall conform to ASTM A615, Grade 40 deformed bars, or ASTM A616, Grade 40 deformed bars.
  - d. Mortar Materials
    - (1) Sand - ASTM Designation C144, passing a No. 8 sieve.
    - (2) Cement - ASTM Designation C 150, Type 1.
    - (3) Water - shall be potable.
  - e. All joints shall be fully sealed and waterproofed. Rubber gaskets for precast concrete manhole sections shall meet

the requirements of ASTM C443. The gasket shall be the sole element depended upon to make the joint flexible and watertight.

- f. Openings in manhole section for sewer connections shall be cast into the manhole at the point of manufacture as specified by the connector manufacturer. A flexible pipe-to-manhole connector shall be employed in the connections of the sanitary sewer pipe to precast manholes. The connector shall be the sole element relied on to assure a flexible, watertight seal of the pipe to the manhole. The connector shall be constructed solely of polyisoprene or natural rubber and shall meet and/or exceed the requirements of ATM C923. The resilient connectors shall be A-Lok Products, Inc., Press-Seal Gasket Corporation, or similar manhole connectors approved by the Engineer. Openings shall be a minimum of 6 inches above the manhole base.
- g. In the field, any additional openings needed shall be made by core drilling and booted as approved by the Engineer. A flexible pipe-to-manhole connector shall be employed in the connection of the sanitary sewer pipe to precast manholes. The connector assembly shall be the sole element relied on to assure a flexible watertight seal of the pipe to the manhole. The rubber gasket shall be constructed solely of polyisoprene or natural rubber and shall meet/exceed the requirements of ASTM C923. If metal, the internal expansion sleeve and the external compression clamps shall be constructed of Series 304 or Series 305 non-magnetic stainless steel and shall utilize no welds in its construction.
- h. Precast manhole sections shall be steam cured and shall not be shipped from the point of manufacture for at least five days after having been cast. The exterior surface of each section shall be thoroughly coated with a coal tar epoxy type coating as manufactured by TNEMEC Co, Tnemec-46H413 Hi-Build TnemeTar; or approved equal by the Engineer. Final dry mils thickness shall be a minimum of 12 mils. Monolithic concrete manholes and other concrete structures shall be cured for a minimum of seven days and then coated in the field with a coal tar epoxy type coating as mentioned above.
- i. Manhole castings shall be of good quality cast iron and/or ductile iron, conforming to ASTM Designation A48. Castings shall have a total weight of not less than 335 pounds and shall conform to the design of the manhole casting as shown on the standard detail sheet. Castings

shall have three bolt holes equally spaced around base of frame and shall be securely anchored to cone section to provide a water tight-fit with three or four 3/8-inch stainless steel bolts and expansion shields. Unless specifically designated otherwise, manhole castings shall be the non-locking type.

- j. Manhole steps shall be made from a steel reinforcing rod encapsulated in a copolymer polypropylene resin. The manhole steps shall equal or exceed OSHA requirements. Manhole steps manufactured by M. A. Industries, Inc., PS-1-PF, Clay & Bailey Mfg. Co., or equal, are acceptable.
- k. Any other special manholes, junction chambers, diversion chambers, and miscellaneous concrete structures shall be constructed as detailed on the drawings.
- l. The Contractor may, at his option, furnish and install a combination precast concrete base and first section with precast openings for services. Detailed drawings shall be submitted to the Engineer prior to manufacture.
- m. Precast manhole sections shall have a lifting eye cast into the wall for lifting the section. Lifting holes through the precast section will not be allowed.

- D. Grease Trap: Grease trap tank shall be constructed of 6000 psi concrete. All tank joints shall be sealed watertight with butyl rubber extrudible preformed gasket material. All outside riser ring surfaces shall be waterproofed 1/8" with trowelable grade butyl rubber back plaster.

## PART 3 - EXECUTION

### 3.1 INSPECTION AND REJECTION OF PIPE

- A. The quality of all materials, the process of manufacture, and the finished pipe shall be subject to inspection and approval by the Engineer. Such inspection may be made at the place of manufacture or on the work after delivery, or at both places; and the pipe shall be subject to rejection at any time on account of failure to meet any of the specifications' requirements even though sample pipes may have been accepted as satisfactory at the place of manufacture.
- B. Prior to being lowered into the trench, each pipe shall be carefully inspected, and those not meeting the specifications shall be rejected and at once removed from the work.

- C. The Town or its representatives shall have the right to cut cores from such pieces of the concrete pipe as he desires for such inspection and test as he may wish to apply.
- D. Holes left by the removal of cores shall be filled in an approved manner by and at the expense of the manufacturer of the pipe.
- E. The Town or its representatives shall also have the right to take samples of concrete after it has been mixed, or as it is being placed in the forms or molds, and to make such inspection and tests thereof as he may wish.
- F. Any pipe which has been damaged after delivery will be rejected and replaced.

### 3.2 HANDLING PIPE

Each pipe section shall be handled into its position in the trench only in such manner and by such means as the Engineer approves as satisfactory. As far as practicable, the Contractor will be required to furnish slings, straps, and other approved devices to permit satisfactory support of all parts of the pipe when it is lifted.

### 3.3 NOTICE TO ENGINEER

The Town Engineer shall be notified when the pipes are to be laid in the trench. At least 15 feet of the pipe shall, under ordinary circumstances, be laid before covering begins.

### 3.4 LAYING PIPE

- A. All pipe shall be reinspected for soundness and damage due to handling immediately before being lowered into the trench. Any pipe found to be unsound or damaged will be rejected and shall be removed immediately from the site of the work.
- B. All pipe shall be laid accurately to the required line and grade as shown on the drawings, and in the manner prescribed by the pipe manufacturer and appropriate ASTM Specifications, to form a close, concentric joint with the adjoining pipe and to bring the invert of each section to the required grade. The supporting of pipe on block will not be permitted
- C. Pipe laying shall proceed upgrade, beginning at the lower end of the sewer.
- D. Practically watertight work is required, and the Contractor shall construct the sewers with the type of joint specified.



- E. All pipe shall be laid to the line and grade as shown on the drawings. Variations from a uniform line and grade as shown on the drawings shall be cause for the line to be rejected.
- F. The ends of the pipe shall be satisfactorily cleaned just before laying, and the joint shall be made in a satisfactory manner in accordance with the recommendations of the manufacturer on particular type of joint and the directions of the Engineer. All joint work shall be done by experienced workmen.
- G. PVC (polyvinyl chloride) gravity sewer pipe and fittings, ASTM Designation D3034 SDR 26, shall be installed in accordance with the directions contained in ASTM Designation D2321. Only materials classified as Class I will be acceptable for bedding, haunching, and initial backfill of the pipe placed and compacted in accordance with ASTM D2321.
- H. Joints on PVC pipe shall be the integral bell type gasketed joint designed so that when assembled the elastomeric gasket inside the bell is compressed radially on the pipe spigot to form a positive seal. The joint shall be so designed to avoid displacement of the gasket when installed in accordance with the manufacturer's recommendations. The gasket shall be the only element depended upon to make the joint flexible and watertight.
- I. All PVC pipe entering a manhole shall have manhole waterstop gasket as supplied by the manufacturer firmly clamped around the pipe. If flexible entry type manhole system is used, the waterstop gasket is not required.
- J. All PVC pipe shall have a deflection test performed by the Contractor in the presence of the Engineer or his representative.
- K. All pipe shall be bedded as described in this specification under Pipe Bedding. Bell holes shall be excavated in advance of pipe laying so the entire pipe barrel will bear uniformly on the prepared subgrade.
- L. Each length of pipe shall be mechanically pulled "home" with a winch or come- along against the section previously laid and held in place until the trench and bedding are prepared for the next pipe section. Care shall be taken in laying the pipe so not to damage the bell end of the pipe. Mechanical means consisting of a cable placed inside the pipe with a winch, jack, or come-along shall be considered to pull the pipe home where pushing the pipe will not result in a joint going completely home and staying in place. Pushing the pipe home shall be done by means of a block and push bar. Use of hydraulic excavating equipment as the means of pushing or moving the pipe to grade will not be permitted.

- M. The Contractor shall use laser beam equipment to maintain accurate alignment and grade. A qualified operator shall handle the equipment during the course of construction. If bending of the laser beam due to air temperature variations or dust in the air is apparent "within the pipe" units, a fan shall be provided to circulate the air. However, air velocity shall not be so excessive as to cause pulsating or vibrating of the beam. Survey instruments may be used for checking alignment and grade if questions arise about the accuracy of the work.
- N. Open excavation shall be satisfactorily protected at all times. At the end of each day's work, the open ends of all pipes shall be protected against the entrance of animals, children, earth, or debris by bulkheads or stoppers. The bulkheads or stoppers shall be perforated to allow passage of water into the installed pipe line to prevent flotation of the pipe line. Any earth or other material that may find entrance into the main sewer or into any lateral sewer through any such open end of unplugged branch must be removed.
- O. The Contractor shall conduct a leakage test as described in Sewer Tests of the specification on the first section of sewer of each size and type sewer material installed. No additional sewer pipe shall be installed until the first reach of sewer of each size and each type sewer material has satisfactorily passed the leakage test.
- P. The Contractor shall prevent all ground water and surface water from entering the existing sewer system during construction of a new sewer or force main extension.
- Q. Sanitary sewer designs that require crossing a county legal drain shall be approved and constructed per the latest standards of the Boone County Surveyor's Office.

### 3.5 PIPE BEDDING AND HAUNCHING

- A. Each pipe section shall be laid in a firm foundation of bedding material and haunched and backfilled with care.
- B. Prior to pipe installation, carefully bring bedding material to grade along the entire length of pipe to be installed. To provide adequate support for the pipe, the following bedding procedures are recommended.
  - 1. When Class I material is used for bedding, little or no compaction is necessary due to the nature of the angular particles. A depth of 4 to 6 inches is generally sufficient to provide uniform bedding.

- C. Bedding material shall have a minimum thickness beneath the pipe of 4 inches (100 mm) or one-eighth of the outside diameter of the pipe, whichever is greater, and shall extend up the sides of the pipe one-sixth of the outside diameter of the pipe.
- D. For rigid pipe, such as concrete or ductile iron, backfill between the bedding material and a plane 12 inches (300 mm) over the top of the pipe shall be hand placed finely divided earth, free from debris and stones, or granular backfill if required.
- E. For flexible pipe such as PVC, the placement of embedment material, consisting of bedding, haunching, and initial backfill, must be done with care. The ability of the pipe to withstand loading in a trench depends a large part on the method employed in its installation. Class I material, as defined in specification Section 02222, Article 2.01, paragraph A, shall be used as embedment material for flexible pipe. Bedding thickness shall be as specified in paragraph C of this Section. The haunching material (the material from the bedding to the pipe springline) and initial backfill (the material from the pipe springline to a plane 12 inches over the top of pipe), shall be hand placed. Care must be taken to not cause damage by compacting the material directly over the pipe.
- F. In yielding subsoils, the trench bottom shall be undercut to the depth necessary and backfilled with graded, crushed stone to form a firm foundation.
- G. Where excavation occurs in rock or hard shale, the trench bottom shall be undercut and a minimum of 6 inches (150 mm) crushed stone bedding placed prior to pipe installation.
- H. Manholes and Other Structures
  - 1. Manhole bases shall be cast-in-place concrete, reinforced as shown on the Standard Detail Sheet, or monolithic base and first section combination. Manhole bases shall be cast or placed on a minimum of 6 inches of compacted crushed stone.
  - 2. Manhole channels or inverts shall be preformed and poured with Class "B" concrete to the spring line of the connecting pipe. The finished invert shall be a semicircular shaped smooth channel directing the flow to the downstream sewer.
  - 3. All manhole frames shall be cast or drilled with four holes equally spaced around base of frame and securely anchored to cone section with three or four (4) 3/8-inch stainless steel bolts, nuts and washers. The joint between the casting frame and cone section shall be sealed with a pliable butyl rubber and coated with a coal

tar epoxy coating upon reaching its final set to become a watertight joint.

### 3.6 HOUSE/BUILDING SERVICES

- A. The Contractor shall install 6-inch diameter house/building service sewer, as shown on the Standard Detail Sheet. The house/building service shall extend from a "wye" or "tee" fitting in the main sewer line to the property line or easement line, unless otherwise stated.
- B. The Contractor shall contact the individual property owners for the preferred location of the house/building service to best suit the property owner's needs. If the Contractor is unable to contact the property owner in advance of laying the main sewer by or across the property, the Contractor shall so notify the town's Engineer in writing.
- C. Fittings for house/building service connections on a main line sewer 15 inches in diameter or smaller shall be tees or 45-degree wyes and shall be of the same material as the main line sewer. Intrusion of house/building services into the flow way of the main line sewer shall not be permitted.
- D. House/building services and connections on main line sewers greater than 15 inches in diameter shall be of a type that will maintain the structural integrity of the main line sewer and provide a watertight connection. Intrusion of house/building services into the flow way of the main line sewer shall not be permitted.
- E. Six-inch lateral pipe shall connect to the main line sewer at an angle of 15 degrees to 45 degrees from the spring line and shall include the necessary bends and straight pipe sections to reach the property line at the elevations specified. A pipe stopper or a bell cap shall be placed on/in the last bell. This stopper or bell cap should be compatible with the type of infiltration/exfiltration test performed on the sewer.
- F. The Contractor shall furnish and use the proper fittings, couplings, and adapters suited to make the transition between different pipe materials which will maintain the structural integrity and the watertightness of the entire sewer system. For connection of service lateral, see Figure S-15 for detail of connection.
- G. At the discretion of the town's Engineer, when and where he feels that improper installation practices are suspected, or questionable bedding materials and methods are employed, or where the installations are severe, the Contractor will have to perform deflection testing on the 6-inch house laterals as specified in Article 3.9.

- H. Backfill around fittings and lateral pipe shall be carefully placed and compacted to prevent damage from backfill settlement and shall be installed in same manner as described for sewer installation.
  - I. The Contractor shall mark the end of each house lateral with a 5/8-inch steel rod 5 feet long placed vertically over the end of the lateral. The rod shall be painted green and left sticking above the existing ground not more than 1 inch.
  - J. The Contractor shall keep accurate horizontal and vertical location measurements of each house/building service installed. The location of all house/building services shall be shown on record drawings as noted in Section 1.17 Record Drawings. The accuracy of the measurements shall be the Contractor's responsibility.
- 3.7 STUBS, CONNECTIONS, BULKHEADS, AND MISCELLANEOUS ITEMS OF WORK
- A. Where special junction chambers are to be constructed or where existing sewers carrying sanitary sewage are encountered, the Contractor shall provide and maintain temporary connections to prevent a nuisance.
  - B. Where called for shop connections and stubs for future sewer connections shall be provided.
  - C. New sewer connections to existing manholes shall be neatly made by core-drilling and installing a flexible pipe-to-manhole connector providing a watertight connection.
  - D. The Contractor shall not connect any existing sewers or house/building services prior to the completion of the exfiltration/infiltration tests, air tests, and acceptance of the sewer without the written permission of the Engineer.

### 3.8 VERTICAL DEFLECTION TESTING

For PVC pipe, the entire length of installed mainline pipe shall be tested for acceptance with an approved go-no-go mandrel under the observation of the Engineer. The testing shall be conducted after the final backfill has been in place for at least 30 days. No pipe shall exceed a deflection of 5%. The deflection test shall be run using a mandrel having a diameter equal to 95% of the inside diameter of the pipe in accordance with ASTM D3034 Appendixes. The pipe shall be measured in compliance with ASTM D-2122. All pipe exceeding the allowable deflection shall be replaced, repaired, and retested.

### 3.9 INFILTRATION LIMITS

- A. Maximum infiltration/exfiltration limits for all new sanitary sewers shall not exceed 50 gallons per inch of diameter per mile of pipe per 24 hours for any section of the system. All sections of the sewer shall be tested, and any sections not meeting this infiltration standard shall be repaired and retested.
- B. The Contractor shall note the special provision under Article 3.04, paragraph 0., that the first section of sewer of each size and type of sewer shall be given a satisfactory leakage test before proceeding with any additional construction.

### 3.10 SEWER WATERTIGHTNESS TESTING

- A. Tests for watertightness shall be conducted on all installed sewers in the presence of and in the manner accepted by the Engineer. The Contractor shall furnish and install all equipment necessary for the sewer tests.
- B. Watertightness tests shall be conducted on short sections of the sewer as soon as the manholes have been constructed and the backfilling completed.
- C. Where the section tested is in excess of the allowable limits, the Contractor shall correct the construction of the sewer so that the section tested is within the allowable limit. All methods and materials used in the repair shall be approved by the Engineer.
- D. The program of testing shall fit the conditions as determined by the Engineer using Air Test for Leakage.
  - 1. The Air Test for Leakage
    - a. The air test for leakage shall be used to test sewer watertightness on all sewer pipe unless otherwise noted.
    - b. The ends of the sewer section being tested shall be sealed and properly blocked. The seal at one end shall have an orifice through which to pass air into the pipe. An air supply shall be connected to the orifice at one end of the section. The air supply line will contain an off-on gas valve and a pressure gauge having a range from 0 to 25 psi. The gauge shall have minimum divisions of 0.10 psi and shall have an accuracy of the nearest  $\pm 0.1$  psi. The seals at each manhole shall be properly blocked to prevent displacement while the line is under pressure.

2. Procedure for Conducting a Low Pressure Air Test
- a. Clean pipe to be tested by propelling a snug fitting inflated ball through the pipe by water pressure or other adequate method. This step is important because it not only flushes out construction debris, but the water used to flush the ball through the pipe dampens the pipe wall. The rate of air loss through pipe wall permeation can be significant on dry pipes.
  - b. Plug all pipe outlets with pneumatic plugs having a sealing length equal to or greater than the diameter of the pipe to be tested. The pneumatic plug shall be able to resist internal testing pressures without requiring external bracing.
  - c. Once the pipe outlet plugs are securely in place, pressurized air is introduced to the system. The air shall be fed through a single control panel with three individual hose connections as follows:
    - (1) from control panel to pneumatic plugs for inflation in sewer pipe;
    - (2) from control panel to sealed line for introducing the pressurized air;
    - (3) from sealed line to control panel. This line will enable continuous monitoring of the air pressure rise in the sealed line.
  - d. The air shall be introduced slowly to the section of pipe under evaluation until the internal air pressure is raised to 4.0 psig greater than the hydrostatic pressure head created by the existence of groundwater that is over the pipe section.
  - e. A minimum of two minutes shall be provided for the air pressure to stabilize to conditions within the pipe. (This stabilization period is necessary for variations in temperature to adjust to the interior pipe conditions.) Air may be added slowly to maintain a pressure to 3.5 to 4.0 psig for at least two minutes.
  - f. After the stabilization period, when the pressure reaches exactly 3.5 psig, the stopwatch shall be started; and when the pressure reaches 2.5 psig, it is stopped. The portion of the line being tested shall be acceptable if the time in minutes for the air pressure to decrease from 3.5 psig to 2.5 psig is greater than the time shown in the following table.

Pipe Diameter, In.	Minimum Time, min:s	Time for Longer Length, s	Specification Time for Length (L) Shown, min:s			
			100 ft	200 ft	300 ft	400 ft
4	3:46	0.380 L	3:46	3:46	3:46	3:46
6	5:40	0.854 L	5:40	5:40	5:40	5:42
8	7:34	1.520 L	7:34	7:34	7:36	10:08
10	9:26	2.374 L	9:26	9:26	11:52	15:49
12	11:20	3.418 L	11:20	11:24	17:05	22:47
15	14:10	5.342L	14:10	17:48	26:42	35:36
18	17:00	7.692 L	17:00	25:38	38:27	51:16
21	19:50	10.470 L	19:50	34:54	52:21	69:48
24	22:40	13.674 L	22:47	45:34	68:22	91:10
27	25:30	17.306 L	28:51	57:41	86:32	115:22
30	28:20	21.366 L	35:37	71:13	106:50	142:26
33	31:10	25.852 L	43:05	86:10	129:16	172:21
36	34:00	30.768 L	51:17	102:34	153:50	205:07

- (1) In areas where the groundwater is above the top of the pipe, the test pressures shall be increased by 0.433 per foot of groundwater. (e.g., if the groundwater is 1 1/2 feet, the 3.5 to 2.5 pressure drop will be increased by 5 psi. The time then will be measured for a pressure drop from 8.5 psi to 7.5 psi.) Groundwater level will be determined by one of the procedures outlined in this Section.

### 3. Safety Precautions During Air Test

- a. The air test may be dangerous if, because of ignorance or carelessness, a line is improperly prepared. It is extremely important that the various plugs be installed and braced in such a way as to prevent blowouts. Inasmuch as a force of 250 pounds is exerted on an 8-inch plug by an internal pipe pressure of 5 psi, it should be realized that sudden expulsion of a poorly installed plug or of a plug that is partially deflated before the pipe pressure is released can be dangerous.
- b. As a safety precaution, pressurizing equipment should include a regulator set at perhaps 10 psi to avoid



overpressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manholes during testing.

4. For sewers 30-inches and greater in diameter, joint testing is an acceptable method of testing. Joint testing shall be accomplished by isolating each joint and applying low pressure air. The line shall be acceptable if each joint passes the air test. The joint will be considered acceptable if the air pressure being applied to the joint drops less than 1 psi in three minutes. The air pressure applied shall be 4 psi over and above the groundwater back pressure. Groundwater shall be compensated by increasing the 4 psi test pressure by 0.433 for each foot of groundwater. It is the Contractor's responsibility to determine the groundwater level.

### 3.11 MANHOLE VACUUM TESTING

- A. A vacuum test shall be conducted by the Contractor on all manholes to ensure watertightness and manhole integrity.
- B. The equipment required to conduct a vacuum test on manholes includes inflatable pipe plugs, test head, vacuum pump, flexible air hose, and a vacuum gage. The test equipment shall be capable of drawing a vacuum of 10-inch Hg. The equipment shall be designed specifically for the purpose of testing manholes and shall be as manufactured by P.A. Glazier, Inc., Worchester, Massachusetts 10002, or equal.
- C. The procedure for conducting an air test on manholes shall be in accordance with the following procedure:
  1. Each manhole shall be tested immediately after setting the casting and prior to backfilling around the structure.
  2. All lift holes shall be plugged with non-shrink grout.
  3. All pipes entering the manhole shall be securely plugged and adequately braced against the inside of the manhole to prevent being drawn out of the pipe.
  4. The test head shall be placed on the inside of the casting frame and sealed with an inflatable seal.
  5. A vacuum of 10 inches of mercury (Hg) shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum to drop to 9 inches. The manhole shall pass if the time is greater than the following:

<u>Manhole Size</u>	<u>Minimum Test Time</u>
48"	60 seconds
60"	75 seconds
72"	90 seconds

### 3.12 CLOSED CIRCUIT TELEVISION INSPECTION

- A. All sections of sewers shall be inspected by closed circuit television.
- B. All unacceptable conditions found during television inspection must be corrected by the Contractor and re-televised.
- C. Unacceptable conditions are conditions that adversely affect the ability of the system to function as designed or to be properly maintained and may include, but are not limited to, the following:
  - 1. Protruding taps
  - 2. Cracked or faulty pipe
  - 3. Misaligned or deformed pipe
  - 4. Debris in line
  - 5. Infiltration / exfiltration
  - 6. Excessive gaps at joints
  - 7. Bellies or sags with a depth greater than or equal to 10% (or a maximum of 1-1/2 inches) of pipe diameter and/or a length greater than 25 feet.
- D. The Contractor shall clean the sewer, where required, one section at a time.
- E. The cost of this work shall be included as part of the bid, and no additional compensation will be made to the Contractor.
- F. See Specification Section 02750 Sewer Televising for procedures.

### 3.13 RECORD DRAWINGS

- A. The Contractor shall prepare or be responsible for the preparation and submittal of record drawings as described in Section 01001, Article 1.17.
- B. Record drawings shall be certified to accuracy by a registered professional Engineer.

## PART 4 - FIGURES

### 4.1 STANDARD DETAILS

<u>Figure</u>	<u>Description</u>
S-1	Standard Sanitary Manhole Detail
S-2	Standard Sanitary Manhole Spacer Ring Detail
S-3	Standard Sanitary Manhole Frame and Cover Details
S-4	Force Main Discharge Detail
S-5	Sewer Pipe Bedding Details
S-6	Concrete Encasement Detail
S-7	Drop Pipe Details
S-8	Alternate Drop Pipe Details
S-9	Jacking and Boring Detail
S-10	House/Building Service Detail-1
S-11	House/Building Service Connection Detail-2
S-12	House/Building Service Bedding Detail
S-13	House/Building Service Clean-out Detail
S-14	Grease Trap Detail
S-15	Flexible Sewer Saddle Detail

END OF SECTION 02731